1979
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REVIEW
PREVIEW

μP Development Systems

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Increased choices, greater universality and more usability to come

No other industry can claim advances in technology comparable to those in the semiconductor industry that have taken place in the last decade. An important element — perhaps the most important — has been the microprocessor "explosion". Microprocessors are now incorporated into products representing an incredibly wide range of industries and applications.

This pervasiveness has caused an aftershock for the microprocessor user who needs to understand how to adequately select, program and develop the microprocessor-based system.

While the microprocessor is *better*, it is also *different*. During the pre-microprocessor era, an idea became a product through a hardware-oriented process. By contrast, development (and performance) of a microprocessor-based product is primarily software dependent and requires an expensive array of tools. Another key difference can be summed up quite briefly: there are at least 20 different microprocessor types which may be appropriate for a given application! Moreover, there are many applications which are optimized by utilizing several different microprocessor types in a single system.

In addition, microprocessor technology does not stand still, as new and more complex central processing and peripheral IC's are introduced each year. The user's problems of selecting the right microprocessor(s) as well as developing a system is becoming increasingly complex.

These devices are now finding their way into the control systems of everything from sewing machines to satellites. And more and more companies are becoming dependent on microprocessor development systems for software/hardware development and integration. The increasing complexity and multiplicity of types of microprocessor and microcomputers has correspondingly increased the complexity of the development systems needed to support them.

The high cost factor and difficult selection process are forcing trends to a choice of universal systems that can be used with more than one microprocessor family. Most recently, instrument companies began filling the obvious gap in the market by introducing low cost, "add-on" tools for universal microprocessor support.

During 1980, two conflicting trends should continue to mature: increasing capability/price and decreasing capability/price! The common element will be support of multiple microprocessors and users. Users will be offered many more capability/price options than ever before and the pervasiveness of integrated electronics will increase in a widening circle of applications.

From multi-functionality to universality

Microprocessor development systems were conceived by semiconductor companies simply as a means to sell their chips. The systems were multifunctional only in the sense that they were designed to meet several needs in the marketplace, allowing users to:

1. Get quick exposure to the latest in microprocessors.
2. Do preliminary, microprocessor evaluation.
3. Do prototyping of trial circuits and debug them.
4. Develop software for the final products.
5. Train new engineers in microprocessor application.

Very quickly, users found that despite the power of dedicated systems, device-specific development systems locked them into one brand of microprocessors even though such systems had been designed to be upgradable to newer microprocessors. However, a beneficial by-product to the user was the lower cost of development. He could now prorate the cost over several generations of the same microprocessor family.

Recently, some semiconductor manufacturers added a limited degree of "universality". For example, National Semiconductor Corp. designed its specialized STARPLEX development system to also serve as a general-purpose computer system. When not being used to develop microprocessor applications, STARPLEX can be used to produce documentation or serve as a node in a larger network.

Incorporating a variety of components, (central, processor with 64k bytes of memory, dual floppy disks, video terminal, multifunction keyboard and printer in a single desktop enclosure) this system — even as a development tool — leans toward universality. It is designed to support the company's second-sourced version of the 8080. As in-circuit emulation capability is added, it can also be used with any microprocessor that has similar architecture and

instruction sets, (including the single chip 8048 microcomputer family, the 8085, and Zilog's Z80, as well as National s NSC800, which combines 8085 and Z80 approaches.)

True universality in development systems became a reality in 1977 when Tektronix introduced its 8001 and 8002A. Furthermore, the entrance into the field during 1979 by Gen Rad/Future Data (with its 2300 Universal Multistation Microcomputer Development Systems Series,) and Hewlett-Packard (with its 64000 Microcomputer Development System) has made universality a legitimate trend. These systems expand user functions with hard disk, high capacity memory and multi-user work stations.

Born also out of the need for lowering the cost of microprocessor development was the introduction in 1979 of inexpensive design aids such as the Millennium Series 1000 MicroSystem Designer, and the Series 2000 MicroSystem Emulator.

All in all, architectural approaches may differ, but the result is the same: development systems are becoming universal rather than dedicated to a particular processor.

Tektronix 8001/8002A: the first universal system

With the introduction of the 8001 and 8002, Tektronix Inc. became the first vendor to offer true universality. The 8002A is a full development system, including facilities for program development and assembly, along with in-circuit emulation for debugging. A smaller version, the 8001 is offered to those who already have program development equipment but who want to add in-circuit emulation. At present the 8002 supports the F8, 3870, 3872, 6800, 6802, 1802, 8080A, 8085, 8048, 8049, 8021, 8035, 8039, 80396 and Z80 eight bit microprocessors, and the TMS 9900 and SBP 9900 16 bit products. Plans are on the drawing boards to add several newer microprocessors and single chip microcomputers.

The 8002 is basically a multiprocessor, single bus (16 bit) system, in which two or more processors reside on the same system bus and are dedicated to various tasks during the development process.

The 8002 achieves universality by splitting into three functional areas, each supported by its own microprocessor. A "system processor" used to control the disk operating system as well as such jobs as file management and system input and output. A second "emulator" processor personalizes the system to the target microprocessor, and executes the program in the prototype system controlling the prototype input/output. The third CPU – the "assembly" processor – has only one job: it performs program assembly in a table-look up mode.

As many as two different slave or emulator processors can be installed simultaneously in the 8002, and then individually controlled through operator command. Since the master processor need not be changed to accommodate new emulator units, all operating system software remains the same.

The 8002 consists of:

- The basic system box, which holds the processor cards, random access memory, interface boards, and a programmer for read-only memory.
- A video terminal for interactive programming.
- A dual floppy disk capable of storing 300 kilobytes on each disk.
- A real time prototype analyzer.

In running the system, the user enters a program and then edits it. The program is converted to object code for the target microprocessor, and the object code is stored on the disk. The program then is debugged while it runs on the emulator CPU.

By plugging a cable into the socket where the actual microprocessor will be inserted in the prototype, the user gains access to all its I/O circuitry, while using the system's memory for program storage. Finally, when the user is satisfied with the program, he transfers it to PROMS which can then be inserted in the prototype and debugged. The 8002 starts at about $14000.

Other Universal Systems

Like Tektronix' 8002, the Gen Rad/Future Data 2300 series has multiprocessor architecture. It differs, however, in its multibus emulator. In the 2300's multiprocessor, multibus architecture, each emulator processor has its own memory and processor/emulator bus, which permits independent and simultaneous operation with the system processor as well as other emulator processors. Since each processor has its own bus, a variety of different types of microprocessors can be handled. At present, complete support is available for the 8086, 8080, 8085, 6800, 6802 and Z80. Starting price is about $12,500.

HP's Entry

Unlike the multiprocessor based Tektronix 8002 or the Future Data 2300 series, the HP64000 system is centered around a 16 bit host processor, a 20 megabyte (expandable) hard disk, 64k bytes of RAM, 16k bytes of ROM, I/O and keyboard/display control. Slots accept the following options: a minicartridge tape drive for software loading and file backup; a universal PROM programmer with front panel socket; and an emulation and logic analysis subsystem. The subsystem contains an emulation control board and pod with the microprocessor to be emulated; 8 to 128k bytes of RAM, and a logic analyzer. The host processor and emulator run simultaneously without interference and with independent buses and memory. Currently the 64000 supports the 6800, 8080, 8085, and Z80, but it is designed to support most 16 bit devices. It also anticipates the requirements of 32 bit devices.

Four buses provide the 64000 with its flexibility: a main frame bus, I/O data bus, emulation bus and emulation memory bus. The mainframe bus carries most of the control, command, and other traffic. The I/O bus links the host processor, keyboard, tape drive and I/O ports. A pod and connector plug extend the emulation bus to user prototypes, as in other systems, with the logic analyzer dedicated to this bus. Finally, the memory bus gives both the emulating microprocessor and host processor access to emulation memory. Various combinations of the four buses are used during development, under control of the host processor. A minimum system consists of a 20 megabyte disk, a 64100A development station, and a tape cartridge unit with appropriate assembler. Prices range from $35k.- $127k.

Friendliness and Universality

All of the above-listed universal microprocessor development systems are different in approach, but they have, at least, one commonality: they are all moving toward the use of high level languages (HLL). Such languages will provide a more "friendly" interface between the user and his system. Among the leading possibilities for these HLLs are: various versions of Pascal, BASIC, PL/M, FORTRAN

and COBOL. Less common are Focal, FORTH, "C" and PLuS. Other useful languages, including various specialized HLLs, are also beginning to make an appearance.

Such HLLs are "friendly" because they are programmer-oriented and more easily used than assembly languages. Very few microprocessor characteristics penetrate to the level of an HLL, so a programmer doesn't have to worry about specific microprocessor quirks. An HLL that is easy to learn and use can boost daily code production far beyond that of assembly code.

Typical of these "friendlier" HLLs is a recently enhanced version of BASIC in compiler form, called Modular Development Language (MDL/μ) by Tektronix for its 8002 Microprocessor Development Lab. Although not yet implemented for all the microprocessors that the 8002 can support, the enhanced language permits full program development for the 8080A, 8085, 6800, 6802 and Z80.

This new language incorporates BASIC-like contructs because BASIC, the most widely accepted language in the field, already well known by almost everyone, is easy to understand and just as easy to use. Furthermore, its wide availability on microprocessors, minicomputers and even larger machines offers many opportunities for program transfer.

MDL/u is an extension of ANSI minimal BASIC, developed specifically for microprocessor-based product development. While BASIC satisfies the requirement for simplicity, speed is not its strong point, because it normally runs on an interpreter. MDL/u, however, uses a compiler, so each statement is translated into machine code once, not every time the statement is executed. The final executable code is therefore faster and often smaller than interpreted versions because of the resulting lower overhead.

In-circuit emulators

One of the most powerful features of a large microprocessor development system, both device-specific and universal, is its in-circuit emulation (ICE) capabilities.

To get ICE from the large system vendors, the user must first buy the development system – an expensive proposition. But there are many users who already have access to a computer system that can be used as a software development station. These fortunate users thus have no need to buy another computer or even a microprocessor development station. Companies with dedicated development systems may want to add universal emulation to protect their initial investment and expand the system's flexibility. But, in many cases engineers neither need nor can afford all the resources of a full next generation development system. Emerging, therefore, is a need for "add-on" type instruments which will provide full or limited resources to already existing "hosts".

Suggesting the future availability of add-on microprocessor development tools are two offerings from Millennium Systems: the Series 1000 MicroSystem Designer (uSD) and the Series 2000 MicroSystem Emulator (uSE).

With the Designer system, experienced microprocessor users as well as novices can evaluate microprocessor-based systems. The uSD is both an 8 and 16 bit universal prototyping instrument (simultaneous operation) as well as a training aid. It currently supports the Z80, 8080, 8086, and Z8000 microprocessors. Soon to be added are the 68000, 8085, 8048 and 6809.

This new instrument has many uses including development of trial circuits; debugging of software; and hardware/software integration. Features include hardware breakpoint, register and memory examinations. To explore hardware alternatives for a given chip set, the Series 1000 uSD provides a solderless prototyping area into which microprocessor signals are brought via a flat cable. A MicroCable, with limited emulation capability, is also available and can be plugged into the user system. Controls consist of a hexadecimal keyboard for program entry and a function keyboard on which any given key provides identical functions for all microprocessors. A 16 digit alphanumeric display shows operator prompts and messages.

A further capability of the uSD is its up/down link to a host computer. By adding various personality modules the instrument permits a design group to add support for all popular microprocessors to an otherwise dedicated microprocessor development system. The basic uSD provides up to 2k bytes of system RAM for interaction with the main processor. A built-in peripheral control processor is available for user control of the main processor, while retaining its ability to interact with the user via its own display and keyboards. This unit is priced at less than $2000 for 16 bit microprocessors.

The uSE, in contrast to the uSD, is a sophisticated high performance microprocessor emulator terminal that is designed to work with both general purpose computers and dedicated microprocessor development systems.

Connected to a host computer, the uSE course that computer to act as a microprocessor development system for the 6800, 6802, 8048, 8080, 8085 and Z80.

This high performance instrument operates at speeds up to 6MHz, which allows real time emulation of fast microprocessors. Real time operation of the uSE extends to an optional real time trace capability, a valuable debugging tool that lets the user track the step-by-step performance of his design at full-rated speed. The uSE further provides complete debug facilities, with 8k of RAM available to the user. Also included is the ability to allow DMA operation plus a high speed serial data link. The uSE is priced at less than $6000.

Conclusion

Approximately 28 million microprocessors were shipped in 1978 and this is projected to reach 160 million units by 1983! About 75 different types of microprocessors and microcomputers exist today as the industry steps up to the threshold of the 16 bit era. No wonder this has been called the "microprocessor explosion".

Astute designers today recognize the microprocessor for what it really is, a *component*. It is an amazingly powerful component, but like all other components, must be chosen and applied properly for any given application.

Development systems and design aids were initially the exclusive province of chip manufacturers. Beginning in 1977, though, and fully emerged in 1979, a number of instrument manufacturers have come into the market. They have produced a series of products to provide designers with greatly expanded capability and universality – the support of multiple microprocessors by multiple users.

Two clear trends are now apparent; high-end development systems for multiple users with high price tag; and low- and mid-price instruments for those users who only want to "add-on". The choices have never been better.

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